

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

MYOTHERAPY MASSAGE DEVICE

FIELD OF THE INVENTION

The present invention relates to a massaging device for alleviating lower back myofascial pains, and in particular to a massaging device having at least one protruding massage head to apply pressure, vibration and optionally heat to a focal region of the lower back.

BACKGROUND OF THE INVENTION

Myofascial pains are one of the most common causes of lower back pains. The two most commonly affected lower back muscles are the quadratus lumborum and lumbar paravertebral muscles. Conventional devices used to relieve lower back muscle pains frequently have a vibrating surface or roller surface which makes contact with the lower back region.

Previous devices have not been designed for use with a myotherapy treatment technique. Myotherapy is the treatment of muscle spasms through focally applied pressure to myofascial regions of pain (small bands of muscle spasms). The treatment involves a gradual increase in the applied pressure to release the spasm. The technique has been used for some time to manually treat lower back pain. Massage devices designed for myotherapy treatment are not known.

Massage devices which are worn like a belt to provide general, but not focused, massaging action are known. For example, U.S. Patent No. 4,850,340 discloses a device for applying heat and vibration to the body by generating a magnetic field to relieve pain and stiffness, which device has individual hollow cases pivotally coupled together in a stand of cases, the ends of which are coupled to belt portions adapted to be attached together to support the strand around a body member. Similarly, U.S. Patent No. 4,732,140 describes a vibratory massage device which has several belts of varying sizes, to which one or two vibrator units can be releasably attached for use on various body parts. These devices do not apply focussed pressure to the body areas to be treated.

Massaging devices for applying massaging action against the lower back by lying against the device are also known in the prior art. Typically, such devices are pad- or pillow-like and apply general massaging action to the body lying or sitting on the device, as shown in U.S. Patent No. 3,854,474 (padding material having massaging mechanisms thereunder), U.S. Patent No. 5,020,517 (back massager attached to a back cushion), U.S. Patent No. 5,503,618 (hydromassage pillow using heated jet pulsed water in a hollow pillow cushion), and U.S. Patent No. 5,188,096 (massage apparatus which includes a mat that slips over the back of a seat). These devices, however, are not adjustable to apply focused massaging action as desired by the operator of the device.

Conversely, U.S. Patent No. 5,179,940 ('940) describes a method for applying a mechanical massage which, while the back of a user is against the back rest of a chair or lying on a bed, uses a massage mechanism device having a pair of spaced parallel arm members and a massaging wheel rotatably supported on one end of each of the arm members. Although the device of patent '940 allows adjustment of the distance between each arm member, it does not permit focused massage utilizing heat or vibration.

U.S. Patent No. 5,582,582 ('582) discloses a device having a massaging mechanism with a plurality of rotatable heads with projections which can be positioned upon the user's back for applying massaging action thereto. The user lies upon their stomach while the massaging mechanism is positioned to apply massage therapy to the user's back. The device of the '582 patent has a frame with legs that permit positioning the frame on top of a massage table/bed. U.S. Patent No. 4,984,568 likewise shows a back massaging device for use on a bed to apply massage therapy to the back while the user is on their stomach, which device has a clamp for securing to a bed frame and an arm for positioning the massaging device. Neither of these devices permits the user to lie on his back and adjust the pressure. Each of these prior devices requires a second person to operate and position the device correctly.

Handheld massaging devices are also well known. U.S. Patent No. 4,632,095 shows a pressure-point attachment for use with electrical hand-held massagers to apply point-pressure combined with vibration to known body pressure points. U.S. Patent No. 3,841,321 discloses a therapeutic massage unit
5 having an enclosed casing with cylindrical body wall and hemispherical end wall, and a handle for manually applying massage to the body.

Massage devices which apply heat and vibration are known in the prior art. For example, U.S. Patent No. 4,722,326 describes a vibratory therapeutic
10 device which has a plurality of interchangeable massage heads, wherein only one massage head may be used at a time and heated air flow may be applied through the head. U.S. Patent No. 5,551,949 describes an infrared massage device which has a hand-held housing, a mechanical vibration generator disposed within the housing, mechanical vibration being transmitted to at least
15 a heat-conductive portion of the housing, and at least one source of infrared radiation. U.S. Patent No. 4,604,993 discloses a hand-held vibratory massage device with a heating element having an applicator head which can apply both tapping and rubbing action. U.S. Patent No. 3,710,785 shows a hand-held
20 massager device used to apply vibration and infrared heat to the body, which massager includes a floating head connected to the main housing of the massager by a coil compression spring.

Handheld devices do not permit the user to apply pressure to their own backs. Such devices require a second person to apply the pressure. Also, the
25 pressure applied manually by a second person does not permit the user to finely adjust the pressure applied but instead requires the user to give the second person verbal instructions which may or may not be understood and followed. Furthermore, prior art devices, which a user lies upon, do not permit focused application of pressure, massaging action, or heat, but instead provide
30 generalized massaging action or heat.

None of the above inventions and patents, taken either singularly or in combination, is seen to describe or suggest the instant invention as claimed.

Thus, a massaging device to alleviate lower back myofascial pain solving the aforementioned problems is desired.

SUMMARY OF THE INVENTION

5 An object of the present invention is to provide directed focal pressure to lower back muscles. Previous devices have not isolated specific lower back muscles for treatment and have not implemented a myotherapy modality of treatment (graduated slight increases in applied focal pressure) using ones own body weight to apply the necessary pressure for the treatment.

10 Another object of the present invention is to provide vibratory massage action to a focal region of the lower back muscles. Previous devices have typically used generalized massage action to the back or require an individual other than the user to operate the device. The present invention permits the user to direct focalized massage action to the back as desired without the further assistance of an additional person.

15 Yet another object of the present invention is to provide heated focal pressure to lower back muscles. The device also possesses the option of using heat within the vibrating head for additional therapeutic benefit.

20 A further object of the present invention is to provide a method for using the device to alleviate myofascial pains of the lower back region. The device is designed to permit the user thereof to gradually increase pressure to the effected muscle regions as desired.

25 The present invention relates to a massaging device used to alleviate lower back myofascial pain. The device possesses at least one protruding massage head which applies vibration and heat with focal pressure to the lower back muscles affected by myofascial pains. Pressure is applied by the individual lying on the device. Each of the protruding components individually can be adjusted to provide the appropriate measure of vibration and, if desired, heat. The distance between massage heads and the height of

each massage head are also adjustable to accommodate individual anatomical variation and to apply optimal focal pressure to the affected lower back musculature. Vibration frequency is maintained from about 90 Hz to about 110 Hz range to optimize the pain reducing benefit. Typically, a vibration
5 frequency of about 100 Hz releases the spasms and pain in the lower back when applied thereto for a short time.

Previous devices were not specifically designed to isolate treatment to these specific lower back muscles. These devices do not employ a gradually
10 increased application of pressure (myotherapy) to release the spasm. They also do not use the individuals own body weight as a means of applying the needed pressure. The present device is used in such a way that the individual simply lies on top of it, with the device applying pressure to the problematic musculature. Lying down enables the lower back musculature a greater degree
15 of relaxation because the lower back muscles are not being used to maintain posture. Relaxed muscles are preferable for optimal therapeutic benefit.

The therapeutic device possesses two spaced substantially parallel vibrating massage heads each of which applies pressure to the specific right
20 and left-sided lower back muscles (quadtratus lumborum and lumbar paravertebral muscles) desired. The device may be used unilaterally or bilaterally. Adjusting the distance between the vibrating heads allows for anatomical individual variability when making contact with the right and left side lower back muscles. The device may be used unilaterally by further
25 increasing the distance between the heads. With the individual lying on the device focal pressure is applied to the spastic region in the muscle. The individual being treated self adjusts a knob or crank provided on the device that finely alters the elevation of the heads. Increased elevation results in increased applied pressure to the spastic region of the muscle (Myotherapy).
30 The treatment may be only minutes in duration and results in a release in the band of muscle spastisity thereby reducing myofascial pain.

An additional therapeutic benefit is obtained due to the vibrational effect of the heads. The frequency of the vibration is controlled by a knob on the power source box. The individual may self-regulate the frequency of the vibration based upon comfort level. The device possesses a range of applied vibration frequency which includes vibrational frequencies from about 90Hz to about 110Hz. As has been shown in the medical literature, reduction in pain is frequently seen at about 100Hz. Further benefit is obtained by the option of providing applied heat to the focal region.

An advantage of the present invention is the ability for the individual to self-regulate the pressure. The knob or crank provided on the device permits the user to adjust and fine-tune the relative vertical height, and horizontal position, of the substantially parallel massage head(s) while in use.

Another advantage is that the device can be operated by the user alone and does not require a second person to help the user focus the treatment. An individual suffering from myocardial pain can treat themselves alone without assistance.

These and other objects and advantages of the present invention will become readily apparent upon further review of the following drawings and specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features of the described embodiments are specifically set forth in the appended claims; however, embodiments relating to the structure of the present invention may best be understood with reference to the following description and accompanying drawings.

FIG. 1 is a schematic perspective view of an embodiment of the myotherapy massage device of the present invention consisting of two opposing massage devices.

FIG. 2 is a side view of a myotherapy massage device according to the embodiment of FIG. 1 showing a schematic of a user's back and relative placement of the device.

FIG. 3 is a top view of the massage device of the embodiment of FIG. 2.

FIG. 4 is a sectional view taken along line 4-4 of FIG. 3.

FIG. 5a is a top view of a lift arm used in the embodiment of FIG. 1.

FIG. 5b is a side view of the lift arm of FIG. 5a.

FIG. 6 is a sectional view taken along line 5-5 of FIG. 3.

FIG. 7 is a schematic view of a control box and vibrator assemblies of the current invention.

FIG. 8 is a schematic view of an alternate embodiment of a myotherapy massage device of the present invention.

FIG. 9 is a schematic view of the embodiment depicted in FIG. 8.

FIG. 10 is a schematic view of a massage head according to the embodiment depicted in FIG. 8.

Similar reference characters denote corresponding features consistently throughout the attached drawings.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A myotherapy massage device 10 for alleviating lower back myofascial pain, as shown in FIGS. 1 and 2, is contemplated by the present invention. The myotherapy massage device 10 possesses at least one massage device 12, as shown in FIG. 3, having a protruding massage head 14 that applies vibration

with focal pressure to the lower back muscles affected by myofascial pains. The massage head 14 may also apply heat to the lower back muscles. The pressure is applied by the individual lying on the device. Each of the protruding components individually can be adjusted to provide the appropriate measure of vibration and heat, if available. The distance between massage heads and the height of each massage head is also adjustable to accommodate individual anatomical variation and to apply optimal focal pressure to the affected lower back musculature.

A method for treating lower back myofosical pains using the myotherapy massage device 10 of the present invention comprises effecting the release of muscle spasms [treatment] by gradually increasing pressure on a targeted focal area. The user lies upon the device so that their back B is in proper orientation with the center line C of the spinal column positioned roughly equidistant between the two massage heads, as shown in FIG. 2. The method for treating lower back pains according to the present invention is discussed hereinafter in greater detail.

The myotherapy massage device 10 for the treatment of lower back myofosical pains has two laterally spaced massage devices 12 each having a massage head 14. Each massage head 14 has a vibrator, as discussed hereinbelow. The myotherapy massage device 10 permits a user to position the massage heads 14 vertically and laterally. The massage heads 14 of the massage device 10 are laterally spaced so that the massage heads are substantially parallel to one another in order to contact a user's back in roughly the same region on both sides of the center line of the spinal column. Each massage head has a motor housing 16 enclosing the vibrator. The motor housing 16 has a tube 20, as shown in FIGS. 6, having a bottom end 30 and a top end 28. A bottom cap 22 is disposed on the bottom end 30 of the tube 20. A top cap 18 is disposed on the top end 28 of the tube 20 opposite the bottom cap 22. The motor housing 16 may have an edge or protrusion, referred to herein as a lip 26, circumnavigating the tube 20 adjacent the bottom end 30 of the tube 20 such that some length 46 of tube extends therebelow. The phrase "laterally

spaced" as used herein defines the substantially opposing but parallel positions of contact areas of the massage heads 14, and is not intended to imply that the massage heads 14 or the massage devices 12 are in fact positioned strictly parallel to one another. The term "contact area" refers to the area of contact
 5 between the massage head 14 and a user of the myotherapy massage device 10.

Note that the motor housing 16 need not be cylindrical as shown in the figures. The tube 20 may have a square, circular, oval, etc. cross section. Furthermore, the top cap 18 has a shape complementary to the tube 20 shape
 10 and need not be rounded but may present a flat surface having any cross sectional shape desired. In fact, the over all shape of the message head need not be restricted to the shape shown in the figures. Message heads of varying shapes, such as square, rectangular and the like, are also contemplated by the present invention. Furthermore, the top cap of the present invention may
 15 include interchangeable shapes/styles which will provide for a precise to a broad contact area as desired. Various shapes/styles may be desired to alter the amount of surface area applying pressure to the region of contact on the body.

20 A retention plate 24 may be disposed between the top and bottom ends 28 and 30 of the tube 20 such that the top cap 18 contacts and rests upon the retention plate 24. Top and bottom spaces 32 and 34 are created within the motor housing 16 by the retention plate 24. The top space 32 adjacent the top cap 18 is smaller than the bottom space 34 adjacent the bottom cap 22. The top
 25 cap 18 may have a convex top surface 36.

The vibrator may have an electric powered motor 38 to produce vibration by turning an axle 42 with an asymmetric weight 40 attached thereto, as shown in FIGS. 6 and 7. The motor 38 may be disposed in the bottom space
 30 34 and attached to the retention plate 24 so that the weight 40 is permitted free movement in the top space 32.

A heater may be disposed in the motor housing 16 to heat the top cap 18. The heater in the top cap 18 is taken from the group consisting of heating coils, infrared radiation, resistance wires, and resistance wire tape, all of which are well known in the industry. The heater may be disposed within the top cap 18 and in contact thereto for conducting heat therethrough. Furthermore, the top cap 18 may be composed of a heat conducting material.

A coil compression spring 44 may be disposed in the motor housing 16 between the bottom cap 22 and the top cap 18 thereby cushioning the vibrator so the vibration of the massage head 14 is dampened with respect to the motor housing 16, in general, and amplified with respect to the top cap 18, in particular. The coil compression spring 44 may be disposed in the motor housing 16 between the bottom cap 22 and the retention plate 24, as shown in FIG. 6, thereby cushioning the vibration such that the vibration of the massage head 16 is dampened with respect to the motor housing 16. In other words, the top cap 18 as it rests on the retention plate 24 is buoyed by the coil compression spring 44 such that the vibration generated by, for example, the rotating asymmetric weight 40, is concentrated in the top cap 18 and the retention plate 24 as the vibrator is attached thereto.

In one of the embodiments, the aspect of the massage device 12 for positioning the massage heads 14 laterally comprises two opposing base assemblies 48 slidably connected to one another by two guide rods 50. Each base assembly 48 is made up of two opposing bases 52, shown in FIG. 3, with the massage heads disposed between the bases, as shown in FIG. 1. A guide 54 is disposed on each base 52 having a first opening 56 therethrough for slidably receiving the guide rod 50, as shown in FIGS. 1, 2 and 3.

Each guide 54 may further comprise a perpendicular threaded second opening 58, bisecting the first opening 56, for receiving a knob 60 having a screw extension 62 thereon which can be tightened to secure the guide rod 50 in place. Other methods for restricting the movement of the base assemblies 48 relative to the guide rods 50 are also contemplated by the present invention.

The aspect of the invention used to position the massage heads 14 vertically utilize the same base assembly 48 as discussed above. The two opposing bases 52 have a lift arm 64 disposed between the two opposing bases 52, as shown in FIG. 4. The lift arm 64 has a length with a first and second end 66 and 68. A structure to attach the massage head 14 at the first end 66 is provided. The structure shown in FIG 4 and 5a is a ring structure 70 which receives the bottom end 30 of the massage head's 14 motor housing 16 therethrough. Other structures such as an open ring structure, or an indentation may be substituted for the ring structure 70. At the minimum, the massage head 14 may be fixed by any well-known means directly to the first end 66 of the lift arm 64 instead of a ring structure 70 or any other structure.

A specific example of a design for attaching the massage head 14 to the lift arm 64 is shown. The lift arm 64 has a ring structure 70 at the first end thereof. The ring structure 70 has threaded openings 71 for receiving screws. A gasket 23 and a plate 21 are provided which have openings 27 and 29 corresponding to the threaded openings 71 of the lift arm 64 which are shown in FIGS. 5a and 5b. The bottom cap 22 is also provided with corresponding threaded openings 31. A rubber gasket 25 may be disposed around the tube 20 of the motor housing 16 adjacent the lip 26. The massage head 14 is disposed on the ring structure 70 so that the bottom cap 22 is adjacent one side of the lift arm 64 while the gasket 23 and plate are disposed on the other side of the lift arm 64. The bottom end of the motor housing is disposed adjacent the bottom cap 18 and the lip 26 then the rubber gasket 25 is placed around the housing and adjacent the lip 26, the remaining gasket 23 and plate 21 are placed over the motor housing as shown. The threaded openings 71 and the corresponding openings 27, 29 and 31 are matched and screws or the like are inserted therethrough in order to secure the massage head in place.

A pivot axis 72 at the second end 68 of the lift arm, and a lift axis 74 disposed between the first and second ends 66 and 68 of the lift arm 64. The pivot and lift axes 72 and 74 may consist of openings with axles extending therethrough, or partially therethrough, provided in the lift arm 64, as shown

in the FIGS. 4 and 5B. Alternatively, the pivot and/or lift axes 72 and 74 may consist of protrusions extending out from the lift arm 64 in a manner analogous to the axles shown, as is well known in the art. A bend 76 in the lift arm 64 may be provided at the point of the lift axis 74 so that the massage head 14 can be positioned correctly for use, as shown in FIG. 5b.

Two linkers 78 are provided to pivotably attach the lift arm 64 to the bases 52 as shown in FIG. 4. Each linker 78 has first and second ends 80 and 82, with the first end 80 of the linker pivotably disposed on the lift axis 72 and the second end 82 of the linker pivotably disposed between the two opposing bases 52. The two ends may have openings for receiving axles or protrusions therethrough. Alternatively, the linker may have protrusions therefrom for insertion into openings at the lift axis and/or in the bases 52.

A pivot axis assembly 84 has a first threaded opening 86 therein forming a passage for receiving a crank shaft 88 and a second opening 90 for receiving the pivot axis 72 of the second end 68 of the lift arm 64. Optionally, the second end of the lift arm may comprise a U-shaped extension 75 such that the pivot axis assembly fits between two legs of the U-shaped extension 75. The crankshaft 88 has a length, a first threaded end 92, and a second threaded end 94. A first spacer block 96 attached to and disposed between the two opposing bases 52 and having an opening 98 for rotatably receiving the first end 92 of the crank shaft 88 therethrough is provided. A second spacer block 100 attached to and disposed between the two opposing bases 52 and having a threaded opening 102 therein for receiving a second end 94 of the crank shaft 88 is also provided. The crankshaft 88 has a handle 104, a crank 106 or other such device for rotating the crankshaft 88 disposed on the first end 92 of the crankshaft 88. The crank 106 may consist of one piece. Alternatively, the crank may have a crank plate 110 with two openings wherein the first opening 112 is affixed to the first end 92 of the crank shaft 88 having a screw 118, or equivalent, through the second opening 114 thereof with a sleeve handle 116 slidably engaged on the screw 118.

A controller 108 for modulating the vibration frequency may be provided. FIG. 7 shows a possible configuration for the controller 108 and the electrical connections to and from the motors 38. The device may operate at a vibration frequency greater than about 90 Hz, and less than about 110 Hz to provide effective pain relief. A vibration frequency of about 100±5 Hz is desired.

An alternative embodiment of a myotherapy massage device 120 of the present invention is depicted in FIGS. 8, 9 and 10. In this embodiment, the massage heads 122 are positioned laterally by a base assembly 126 having two opposing bases 124 slidably engaged in a track 128 on a platform 130. Each massage head 122 is slidably engaged in each base 124 such that the massage heads 122 can be individually positioned vertically.

A method of treating myofascial pain using the myotherapy device of the present invention involves placing the device on a sturdy flat surface such as a floor, table, bed or the like. The device is positioned so that the two vibrating heads of the device come in contact with the right and left sides of the lower back as an individual lies on top of the device. The region treated is between the pelvic hip-bone (the iliac crest) and the ribs. As the individual lies down on the device, the distance between the two vibrating heads is approximately six inches.

The individual may need to make some fine adjustment to the distance between the vibrating heads so that each vibrating head comes in contact with the outer sides of the muscles that run along both sides of the spine thereby placing the point of contact on the lateral aspects of the Quadrates lumborum and erector spinae muscles on both sides of the spine. The height/elevation of the vibrating heads will need to be adjusted by the individual so that adequate pressure is applied to these muscles without causing marked discomfort. The height is adjusted by turning the knob on the side of the device. Approximately one and one half minutes of vibrating pressure are applied to

the muscles. The time and amount of pressure being applied may be altered based upon therapeutic benefits.

Although the present embodiments show lateral and vertical
5 adjustments of the substantially parallel massage heads via mechanical
adjusting devices, additional adjusting devices are contemplated by the present
invention such as, but not limited to, hydraulics, electrical and/or electronics to
provide any or all of the operating and adjustment functions herein. In other
words, automatic apparatuses may be provided to turn a crank to lift the lift
10 arm or to adjust the device laterally. It is to be understood that the present
invention is not limited to the embodiments described above, but encompasses
any and all embodiments within the scope of the following claims.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2